Series 1928 Number 22

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey
of
The Milk River Area, Montana

By

WILLIAM DeYOUNG
Montana Agricultural Experiment Station, in Charge
and
F. O. YOUNGS and T. W. GLASSEY
United States Department of Agriculture

Bureau of Chemistry and Soils

In cooperation with the
Montana Agricultural Experiment Station

For sale by the Superintendent of Documents, Washington, D. C.

BUREAU OF CHEMISTRY AND SOILS

CONTENTS

SOIL SURVEY OF THE MILK RIVER AREA, MONTANA

By WILLIAM DeYOUNG, Montana Agricultural Experiment Station, in Charge, and F. O. YOUNGS and T. W. GLASSEY, U. S. Department of Agriculture

AREA SURVEYED

The Milk River area, including parts of four Montana counties, Hill, Blaine, Phillips, and Valley, is located in the northern part of the State, from 30 to 65 miles south of the Canadian boundary. (Fig. 1.) The area surveyed is long and narrow, ranging from 2 to 15 miles in width from north to south, and it is about 170 miles long from west to east. The boundaries are irregular, having been drawn more or less parallel to Milk River to include the valley of that river and the lower parts of the valleys of its tributaries. In addition, areas of bordering uplands on either side of the valley, the so-called "big bend country," lying north and east of Malta, and the divide between Beaver Creek and Milk River have been included. The total area is 975 square miles, or 624,000 acres.

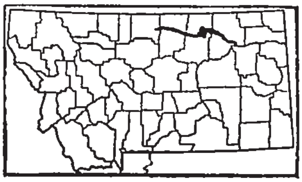


FIGURE 1.—Sketch map showing location of the Milk River area, Montana

This survey was made for the purpose of obtaining basic information regarding the soils of the area now under irrigation, or which may be irrigated in the future, upon which a more scientific land classification might be made, as well as to provide for a plan of land utilization.

In general, the area which the valley of Milk River dissects may be characterized as a gently rolling plain which, since the time of glaciation, has been severely eroded where bordering the major stream courses, and the general relief of the country is rather closely related to the preglacial erosion of the different underlying geologic formations. The elevation gradually increases both northward and southward from the valley of Milk River. Most of the land is in the form of more or less distinct benches. The elevation increases more rapidly toward the south as the Bearpaw and Little Rocky Mountains are approached than toward the Canadian boundary. Some of the higher mountain peaks reach an elevation of about 7,000 feet above sea level, and table-lands, having an elevation of more than 3,000 feet in places, occur south of the Canadian boundary. The rough hilly land south of Hinsdale is locally known as the Larb Hills and reaches an elevation of about 3,000 feet.

The so-called "big bend country" north of the Nelson Reservoir is rugged and severely eroded. Most of the small level plateau remnants are covered with large glacial bowlders and gravel. The remaining land is very rough and the glacial drift has been largely removed, exposing the rather barren partly weathered shales. It is all included in grazing land.

88799—32——1

Except locally where the Judith River sandstone outcrops, the breaks bordering Milk River are comparatively low and more or less rounded. Many of the coulees and larger streams entering the valley have cut through the glacial drift into the underlying shales and sandstones, and in places erosion has removed the entire drift covering, exposing the underlying formation. A more complete description of the topography of northern Montana may be found in the reconnaissance soil reports covering Valley, Phillips, and Blaine Counties.[1]

Geologists believe that the valley now occupied by Milk River was the preglacial course of Missouri River from Havre eastward as far as Malta. The present course of Milk River turns sharply to the north at Malta, although the preglacial depression, through which the Great Northern Railway now runs, apparently continued eastward from Malta, joining the valley of Beaver Creek east of Bowdoin. The valley of Beaver Creek parallels the present valley of Milk River for some distance before joining it west of Hinsdale.

In the vicinity and west of Havre the river valley is narrow, ranging from one-half to three-fourths mile in width. East of Lohman the valley widens considerably at and beyond the entrances of Red Rock Coulee, Clear Creek, Lodge Creek, and Battle Creek, and it ranges from 2 to 5 miles in width. North of Malta the valley again narrows and in few places is more than 1 mile wide until it approaches the mouths of Whitewater and Frenchman Creeks. At the junction of Beaver and Rock Creeks with Milk River, the valley widens considerably but becomes narrower toward Glasgow and Nashua. Milk River follows a very meandering course through the valley. During low water it is a sluggish stream, intrenched from 15 to 20 feet below its flood plain, and it ranges from 60 to 75 feet in width.

Although in general appearance the valley floor is fairly level, it is very uneven in many places. Recent deposits of alluvium have built up the land bordering the present stream course so that it is actually a few feet higher than some of the land farther away from the stream; many sloughs and old oxbows, representing former channels of the river, are filled with water at least a part of the year, and these depressions divide the arable land into very irregular areas and interfere somewhat with its use. Many isolated low glacial mounds and ridges in the valley interrupt the generally level surface relief. The alluvial deposit bordering Milk River, the depressions, and the glacial mounds and ridges interfere considerably with irrigation and retard surface drainage during times of high water.

The elevation of the valley and the fall of Milk River are shown by the elevations of the Great Northern Railway stations distributed along its route. At Havre, near the western edge of the area, the elevation is 2,486 feet above sea level. Eastward from Havre the elevation at Chinook is 2,400 feet; at Harlem, 2,371 feet; at Malta, 2,254 feet; at Glasgow, 2,095 feet; and at Wiota, 2,057 feet. The distance by rail from Havre to Wiota is 173 miles, and the difference in elevation is 429 feet. Owing to the meandering course of the

[1] GIESEKER, L. F. SOILS OF VALLEY COUNTY. Mont. Agr. Expt. Sta. Bul. 198, 57 p., illus. 1926.
——— SOILS OF PHILLIPS COUNTY. Mont. Agr. Expt. Sta. Bul. 199, 61 p., illus. 1926.
——— SOILS OF BLAINE COUNTY. Mont. Agr. Expt. Sta. Bul. 228, 64 p., illus. 1930.

river, the distance by water is greater, which would indicate that the stream has an average fall of less than 2 feet to a mile. The bordering uplands have an elevation of approximately 2,500 feet south of Havre and Chinook, of 2,240 feet on the Saco bench, and of 2,180 feet north of Hinsdale, indicating that the valley floor is slightly more than 100 feet lower than the bordering upland benches.

As the drainage waters of a large part of northern Montana are carried by Milk River, the valley is more or less subject to floods which occasionally do considerable damage to crops and irrigation ditches. Two flood stages of the river occur yearly, the first in early spring, usually during the last part of March and the first part of April, caused by the melting of snow on the prairies; and the second, often augmented by the spring rainfall, in late May and early June when the snow melts in the mountains and on the higher divides. The Chain Lakes Reservoir has been proposed to aid in the control of the flood waters as well as to provide additional irrigation water.

The streams which enter the valley and carry large volumes of water during flood periods are Red Rock Coulee, Lodge, Battle, Thirtymile, Assiniboine, Whitewater, Frenchman, and Rock Creeks from the north, and Clear, Snake, Peoples, Beaver, and Larb Creeks from the south.

The natural surface drainage of the valley is restricted in places, particularly in the lower areas of heavy soil. Many of these areas, scattered throughout the valley, are at some distance back from the stream channels, the banks of which have been built up by alluvial deposits, so that in effect the heavy soil areas are in basinlike depressions not all of which have natural drainage outlets, and open ditches in many places would improve drainage conditions.

The early settlers in the Milk River Valley were chiefly traders and stockmen, some of whom intermarried with the Indians, but no permanent settlements were made before the establishment of the Indian reservation, the present boundaries of which were not fixed until 1885. Prior to 1885, all the territory north of Marias and Missouri Rivers was an Indian reservation. Shortly after 1885, the Indian agency was moved from near Chinook to its present site about 5 miles south of Harlem. Milk River now forms the northern boundary of the Fort Belknap Indian Reservation, the western boundary runs due south from Milk River about 5 miles west of Harlem from near the mouth of Snake Creek, and the eastern boundary runs southwest from the mouth of the old channel of Peoples Creek. Both the eastern and western boundaries extend southward into the Little Rocky Mountains.

Permanent settlement of the agricultural lands of the area really began with the construction of the Great Northern Railway in 1888. The land taken up by stockmen between 1885 and 1895 was near the stream courses and water holes, the possession of which largely controlled the grazing of livestock in the area. All of northern Montana was very sparsely settled during the time that livestock raising was the chief industry. Between the years 1907 and 1917 the "dry-land movement" was at its height, and settlement was largely on nonirrigated land.

The settlement of the irrigated lands began shortly after water was turned into the Harlem and Paradise Canals in 1895. Later

other private projects were started and in 1905 the Federal Milk River project was undertaken.

The present settlers on the irrigated lands are largely of American birth, though some foreign nationalities are represented. The people attracted to the irrigated lands within recent years have come largely from the intermountain States. The settlement and development of the irrigated lands has been slow, and considerable vacant land, suitable for the development of a diversified agriculture, is still available.

Table 1, taken from the annual crop census collected by the Bureau of Reclamation shows the approximate number of people engaged in farming in the Milk River Valley.

TABLE 1.—*Approximate number of people engaged in farming in the Milk River Valley, Mont.*

Division	Farm population	Owners	Renters	Engaged in farming
Chinook	770	93	98	499
Malta	521	95	88	268
Glasgow	228	67	18	153
Total	1,525	255	204	920

A large number of the people living in the different towns throughout the valley are dependent either directly or indirectly on the farming industry. It is estimated that about 5,000 people obtain their livelihood either directly or indirectly from the farming of irrigated lands.

The most important towns throughout the valley, all of which are located on the Great Northern Railway are Havre, Chinook, Harlem, Dodson, Malta, Saco, Hinsdale, Glasgow, and Nashua.

Havre, the county seat of Hill County, has a population of 6,372 according to the 1930 census.[2] With its repair shop and yard facilities it is an important division point on the Great Northern Railway. It is also an important distributing point for the northern part of the State, as it has direct railroad service from Butte, Helena, and Great Falls. Chinook, with a population of 1,320, is the county seat of Blaine County and the site of a beet-sugar factory. Harlem, with a population of 708, is located in the east-central part of the county about 5 miles from the Fort Belknap Indian Agency. Malta, the county seat of Phillips County, is the location of the Bureau of Reclamation headquarters for the Milk River project and has a population of 1,342. Dodson in the western part, and Saco in the eastern part, of Phillips County, are important grain centers and distributing points. Glasgow, with a population of 2,216, is the county seat and most important town of Valley County. Nashua and Hinsdale are important trading points.

Most of the towns in the Milk River area have excellent school facilities as well as modern municipal improvements.

[2] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given whenever possible.

The main line of the Great Northern Railway traverses the area from east to west and furnishes adequate transportation facilities for the agricultural products. It provides facilities for the direct shipment of grain and livestock to either the western or middle-western markets. The local markets are Great Falls, Helena, and Butte. United States Highway No. 2 parallels the railway throughout the entire valley. Improved dirt roads traverse all the better agricultural sections of the area.

CLIMATE

The climate of the Milk River area is characterized by moderately low annual precipitation, a dry atmosphere, hot summers, cold winters, and a large proportion of sunshiny days. During the summer months, there are from 14 to 16 hours of daylight. The valley is subject to the frequent and sudden changes characteristic of the northern Great Plains, particularly during the winter months.

Climatic records for Havre, Chinook, Malta, and Glasgow have been summarized and included in Tables 2, 3, and 4. These stations are distributed, one in each of the four counties, through which Milk River flows.

TABLE 2.—*Normal monthly, seasonal, and annual temperatures at Havre, Chinook, Malta, and Glasgow, Mont.*[1]

Month	Mean				Maximum				Minimum			
	Havre (1880–1927)	Chinook (1896–1927)	Malta (1905–1927)	Glasgow (1894–1927)	Havre	Chinook	Malta	Glasgow	Havre	Chinook	Malta	Glasgow
	° F.	° F	° F.	° F	° F.	° F	° F	° F	° F	° F.	° F.	° F
December	20.4	19 8	19 0	17.3	63	65	55	58	−35	−45	−44	−45
January	12 9	12.1	9 2	8 1	61	65	63	62	−57	−45	−56	−56
February	13.6	13.7	12 2	10.7	63	65	63	63	−45	−50	−49	−53
Winter	15.6	15.2	13 5	12 0	63	65	63	63	−57	−50	−56	−56
March	27.1	26 9	26 0	24.4	76	78	80	73	−26	−36	−30	−45
April	43 7	42 4	43 7	43 8	90	94	92	90	−4	−13	5	−2
May	53 4	54.0	54 0	55 1	94	98	97	98	20	13	18	18
Spring	41 4	41.1	41.2	41.1	94	98	97	98	−26	−36	−30	−45
June	62.0	63 2	63 7	63 7	98	109	105	109	29	29	28	24
July	68 3	69 1	70 0	70 0	102	110	105	113	37	55	36	36
August	65 4	66.0	67.8	67.9	103	109	105	110	27	30	26	37
Summer	65 2	66 1	67 2	67.2	103	110	105	113	27	29	26	24
September	56.4	56 6	56 8	56 6	90	96	96	100	18	20	19	14
October	44.5	44 8	44 0	44 0	86	89	90	89	−7	−9	13	−8
November	31.2	30 4	29 1	27 4	69	82	72	76	−30	−30	−23	−41
Fall	44 0	43 9	43.5	43 0	90	96	96	100	−30	−30	−23	−41
Year	41.5	41.6	41 3	40.8	103	110	105	113	−57	−50	−56	−56

[1] Elevations. Havre, 2,505 feet, Chinook, 2,502 feet, Malta, 2,250 feet; Glasgow, 2,092 feet.

TABLE 3.—*Normal monthly, seasonal, and annual precipitation*[1] *at Havre, Chinook, Malta, and Glasgow, Mont.*

Month	Mean				Total, driest year				Total, wettest year			
	Havre	Chinook	Malta	Glasgow	Havre (1905)	Chinook (1918)	Malta (1910)	Glasgow (1910)	Havre (1884)	Chinook (1927)	Malta (1927)	Glasgow (1916)
	In	*In*	*In*	*In*	*In*	*In*	*In*	*In*	*In*	*In*	*In.*	*In*
December	0 63	0 47	0 41	0 54	0 12	0 11	0 18	0 15	0 72	1 49	1 27	0 56
January	69	61	59	59	85	1 36	09	00	16	43	23	2 50
February	47	38	43	50	14	31	58	45	44	55	38	1 64
Winter	1 79	1 46	1 43	1 63	1 11	1 78	85	60	1 32	2 47	1 88	4 70
March	48	.43	53	85	15	33	42	24	.53	19	20	1 34
April	1 01	91	.82	96	70	35	71	84	25	1 22	90	45
May	2 00	2 05	2 18	2 35	.83	15	89	1 22	3 05	7 18	7 40	2 18
Spring	3 58	3 39	3 53	4 16	1 68	83	2 02	2 30	3 83	8 59	8 50	3 97
June	2 82	2 81	3 82	2 91	1 72	26	64	1 01	4 72	1 27	3 20	4 90
July	1 92	1 73	1 90	1 46	.86	82	1 15	1 81	9 67	4 00	3 67	2 97
August	1 26	1 04	1 23	1 23	30	2 25	76	89	2 61	1 32	1 07	95
Summer	6.00	5.58	6 95	5 60	2 88	3 33	2 55	3 71	17 00	6 59	7 94	8 82
September	1.03	1 05	1 04	1 01	.12	76	27	36	2 69	1 14	2 09	2 37
October	50	45	57	73	.37	1 16	.12	46	41	78	1.26	38
November	77	65	36	48	.60	.15	.51	31	42	1 88	1 03	23
Fall	2 30	2 15	1 97	2.22	1 09	2 07	.90	1 13	3 52	3 80	4 38	2 08
Year	13 67	12 58	13 88	13 61	6 76	8 01	6 32	7 74	25 07	21 45	22 76	20 47

[1] Havre, 1880–1927, Chinook, 1896–1927, Malta, 1905–1927, Glasgow, 1894–1927

TABLE 4.—*Frost data*[1] *collected at Havre, Chinook, Malta, and Glasgow, Mont.*

Station	Average date of last killing frost	Average date of first killing frost	Average frost-free period (days)	Latest recorded date of killing frost	Earliest recorded date of killing frost
Havre	May 16	Sept 19	126	June 6	Aug 25
Chinook	May 14	Sept 18	127	...do....	Do.
Malta	May 21	Sept 25	127	...do....	Do
Glasgow	...do....	Sept. 17	119	June 20	Aug 11

[1] Havre, 1881–1927, Chinook, 1896–1927; Malta, 1905–1927, Glasgow, 1894–1927

The winter and summer extremes of temperature in the Milk River area differ greatly, the highest temperature, 113° F. being recorded at Glasgow and the lowest temperature, −57°, at Havre, but these extremes are seldom reached and are of very short duration. The annual mean temperatures of 40.8° at Glasgow and 41.6° at Chinook show a more equable climate than in States farther east. The average frost-free period ranges from 119 days at Glasgow to 127 days at Malta and Chinook, and in normal seasons, killing frosts rarely occur after May 15 or earlier than September 10. Late spring frosts rarely damage small grain or sugar beets, but early fall frosts may do considerable damage.

The annual precipitation in the valley of Milk River differs considerably from year to year as does its distribution throughout the growing season. During the growing season of 1927, which was an extremely wet year, very little irrigation was necessary at any time during the summer and then only for such crops as sugar beets, po-

tatoes, and alfalfa, but during the growing seasons of 1918 and 1919, which were extremely dry years, all nonirrigated crops were practically a failure. The average annual rainfall recorded for the different Weather Bureau stations ranges from 12 to 14 inches, and normally 60 per cent of the total is received between April 1 and September 1 when it is most needed by the growing crops. The heaviest rainfall usually occurs during May and June, but the spring of 1928 proved to be an exception, and it was necessary to irrigate before the seeds could germinate. July and August are the months when water for irrigation is most needed, particularly for alfalfa, sugar beets, and potatoes.

The Milk River area is more or less subject to strong westerly winds, especially during early spring, and occasionally soil drifting does some damage to early seeded crops if the soil becomes dry. Hot winds from the southwest have caused serious losses to nonirrigated crops in the drier years. Hailstorms of more or less severity occur locally during the summer but are no more frequent than in other parts of the Great Plains area.

AGRICULTURE

Prior to 1885 all the land north of Missouri River was included within an Indian reservation. About 1885 the present boundaries of the Fort Peck and Fort Belknap Indian Reservations were established, but the unreserved public domain was not thrown open to settlement until 1887. When the land was opened for settlement, the large cattle companies began to move their livestock across Missouri River to graze the virgin prairie lands. Soon after 1890, sheep were brought in, and at times surpassed cattle in importance.

No accurate figures are available on the numbers of livestock in the various parts of the State as the size of the herds differed considerably from year to year. In 1902 about 100,000 cattle and 700,000 sheep were in the northeastern part of Montana, and livestock raising was the chief industry until about 1910, but afterwards declined during the time that public lands were being settled under the so-called "dry-land movement." By 1914, however, the numerous smaller herds of livestock offset to some extent the dissolution of large livestock companies.

In the early days the animals were wintered on the open range and as a result heavy losses occurred during severe winters. Later, however, many stockmen began to provide for at least some winter feed as well as protection during the most severe weather. The control of water holes and winter-grazing areas really controlled grazing in the uplands.

Irrigation owes its initial development to the foresight of some of the early stockmen who saw the need of supplementing the winter ranges and preventing losses in severe winters. Several stockmen, working together, constructed a small ditch near the mouth of Thirtymile Creek in 1890, the Harlem and Paradise projects were created in 1895, and other private projects were later formed in Blaine County. The United States Bureau of Reclamation planned and undertook the reclamation of 192,000 acres of valley land in 1902, and the Bureau of Indian Affairs prepared to irrigate land in the valley located within the Indian reservation. The development of the irrigated projects has been very slow for a number of reasons,

chief of which are the large acreage held for speculative purposes, the difficulties which settlers with insufficient capital meet in becoming established on unimproved land, and lack of complete settlement. Mixed grain farming and livestock raising has been the type of agriculture in the older irrigated sections. Alfalfa and bluejoint have been the chief forage crops.

Agricultural conditions have improved somewhat during the last few years since many of the older projects have been organized under the State laws into irrigation districts for the allocation of water rights and construction charges. Provision has also been made for the amortization of construction charges on the Milk River project. To adequately meet the maintenance and construction charges of the irrigation works, the growing of the more intensively farmed crops, such as sugar beets and certified seed potatoes, has been started with fair success. Alfalfa seed is also produced but the yields are variable. The establishment of a beet-sugar factory at Chinook in 1925 has made possible the growing of sugar beets on a commercial scale.

The trend of the agricultural development of the Milk River project exclusive of the Chinook division, is indicated by the acreages and crop yields given in Table 5.

TABLE 5.—*Acreage and yields of irrigated crops in the Malta and Glasgow divisions, Milk River Valley, Mont., 1921 to 1928, inclusive* [1]

Crop	1921	1922	1923	1924	1925	1926	1927	1928
Alfalfa hay . . . acres	3,385.0	4,365.0	3,899.0	3,605.00	4,715.00	4,719.25	4,171.00	4,784.00
Average yield . . . tons	1.7	1.6	1.5	2.10	1.90	2.24	2.10	2.16
Maximum yield . . . do	4.0	4.0	4.9	5.00	4.00	4.00	4.00	4.00
Total yield . . . do	5,775.0	7,106.0	6,036.0	7,495.00	8,863.00	10,418.00	8,784.00	10,354.00
Alfalfa seed . . . acres	163.0	165.0	185.0	115.00	673.75	517.00	. . .	143.00
Average yield . . . bushels	.9	.9	.7	.40	2.20	2.36	. . .	.87
Maximum yield . . . do	2.5	4.0	6.0	2.70	4.50	6.60	. . .	1.00
Total yield . . . do	144.0	154.0	135.0	46.00	1,495.50	1,237.00	. . .	114.00
Sugar beets . . . acres	. . .	3.0	69.0	230.00	987.00	816.50	618.50	678.00
Average yield . . . tons	. . .	5.7	6.8	6.50	8.30	8.70	9.91	9.02
Maximum yield . . . do	. . .	10.0	12.5	15.00	20.00	15.00	14.10	13.88
Total yield . . . do	. . .	17.0	554.0	1,496.00	8,198.00	7,154.00	6,136.00	5,528.00
Beans . . . acres	1.0	25.0	60.0	330.00	36.00	9.25	. . .	. . .
Average yield . . . bushels	13.0	14.2	6.8	5.50	2.80	22.20	. . .	. . .
Maximum yield . . . do	13.0	50.0	12.5	29.00	12.50	32.00	. . .	. . .
Total yield . . . do	13.0	365.0	405.0	1,814.00	102.00	205.00	. . .	. . .
Corn . . . acres	113.0	95.0	453.0	311.00	258.00	29.00	10.00	. . .
Average yield . . . bushels	39.0	35.8	27.5	11.90	18.80	27.20	20.00	. . .
Maximum yield . . . do	60.0	50.0	50.0	20.00	50.00	60.00	20.00	. . .
Total yield . . . do	4,398.0	3,410.0	12,473.0	3,715.00	4,851.00	790.00	200.00	. . .
Native hay . . . acres	8,837.0	10,620.0	11,687.0	7,298.00	9,459.00	8,452.00	7,321.00	7,112.00
Average yield . . . tons	.7	.6	.6	.79	.60	.57	.84	.71
Maximum yield . . . do	1.0	1.2	2.0	2.50	1.50	4.00	2.00	1.00
Total yield . . . do	5,927.0	6,822.0	7,294.0	5,761.00	5,555.00	4,825.00	6,190.50	5,385.00
Oats . . . acres	1,044.0	723.0	812.0	808.00	767.00	800.00	133.00	217.00
Average yield . . . bushels	26.0	16.1	15.6	22.50	32.60	35.50	20.30	40.22
Maximum yield . . . do	80.0	86.0	82.0	51.00	69.00	80.00	122.00	95.00
Total yield . . . do	26,939.0	11,651.0	12,711.0	18,208.00	25,036.00	28,465.00	2,700.00	8,755.00
Potatoes . . . acres	35.0	211.0	73.0	56.00	108.50	153.20	72.75	32.00
Average yield . . . bushels	164.0	143.0	93.0	117.00	136.70	172.00	220.00	164.20
Maximum yield . . . do	400.0	300.0	250.0	400.00	400.00	400.00	600.00	225.00
Total yield . . . do	5,734.0	30,307.0	6,804.0	6,615.00	14,784.00	26,355.00	16,040.00	5,070.00
Certified seed potatoes . . . acres	. . .	. . .	. . .	. . .	20.10	. . .	13.00	19.00
Average yield . . . bushels	. . .	. . .	. . .	. . .	182.80	. . .	177.00	394.74
Maximum yield . . . do	. . .	. . .	. . .	. . .	464.00	. . .	200.00	500.00
Total yield . . . do	. . .	. . .	. . .	. . .	3,658.00	. . .	2,300.00	7,500.00
Wheat . . . acres	2,548.0	1,854.0	1,707.0	1,036.00	1,797.00	1,943.00	1,242.00	2,162.00
Average yield . . . bushels	12.0	11.2	7.7	11.90	13.30	17.50	12.80	16.11
Maximum yield . . . do	30.0	30.0	27.5	30.00	27.30	52.00	50.00	42.00
Total yield . . . do	31,173.0	20,757.0	13,247.0	16,475.00	23,842.00	33,302.00	15,908.00	33,503.00

[1] Data from Bureau of Reclamation.

The Chinook division is divided into five separate irrigation districts, all of which have early water rights in Milk River. These districts have extended their canals and have entered into contracts with the Bureau of Reclamation for additional water obtained from the St. Mary's storage reservoir. The irrigable acreage and the estimated total cropped and irrigated acreage of the Chinook division for 1925 is given in Table 6.

TABLE 6.—*Irrigable and cropped area, Chinook division, 1925*[1]

Irrigation district	Irrigable land	Estimated total cropped and irrigated land
	Acres	*Acres*
Fort Belknap	7,800	5,400
Alfalfa Valley	3,600	1,400
Zurich	8,100	8,000
Harlem	10,900	3,900
Paradise Valley	10,800	8,900
Total	41,200	27,600

[1] Data from Bureau of Reclamation.

In Table 7 are given the total irrigable acreage and the total acreage actually irrigated for the production of farm crops for the three divisions of the Milk River project as reported in 1926.

TABLE 7.—*Total irrigable acreage and total acreage actually irrigated in the three divisions of the Milk River Valley, Mont., 1926*[1]

Division	Irrigable land	Irrigated land
	Acres	*Acres*
Chinook	26,534.7	20,827.0
Malta	27,742.1	14,244.2
Glasgow	8,427.1	4,559.0
Total	62,703.9	39,630.2

[1] Data from Bureau of Reclamation.

A large part of the land in the Malta and Glasgow divisions is still unpatented, although there is some deeded land throughout the project. Construction charges on the irrigation system have been allocated on the project and amount to approximately $57 an acre. Payments are to extend over a series of years.

Summarized acreages and yields of the various crops grown under irrigation on the entire Milk River project as reported for the crop year 1928 are given in Table 8. The total area in crops was 39,328 acres which is reported to be about 60 per cent of the irrigable acreage of the project.

TABLE 8.—*Acreage and yields of crops grown under irrigation, Milk River project, Montana, 1928* [1]

Crop	Acres	Total yield	Acre yields	
			Average	Maximum
		Tons	*Tons*	*Tons*
Alfalfa hay	9,585	21,792	2.27	4.00
Sweetclover hay	40	40	1.00	1.00
Bluejoint hay	10,943	8,609	.79	1.00
Grain hay	50	57	.95	1.13
Corn fodder	74	280	3.78	6.00
Sugar beets	2,814	22,559	8.02	15.00
Pastures	864			
		Bushels	*Bushels*	*Bushels*
Wheat	7,490	150,573	20.10	44.40
Oats	2,512	103,394	41.16	95.00
Rye	100	2,000	20.00	20.00
Barley	1,306	48,213	36.91	66.67
Flax	1,799	16,511	9.18	20.00
Alfalfa seed	181	342	1.89	6.00
Sweetclover seed	15	75	5.00	5.00
Corn	4	200	50.00	50.00
Potatoes	341	63,740	186.78	225.00
Potatoes, certified seed	181	39,630	218.85	500.00
Garden	29			

[1] Data from Bureau of Reclamation.

In cash return an acre, sugar beets now rank first among the irrigated crops. Although the acreage of sugar beets in 1928 was less than half that of spring wheat, the value of sugar beets was greater, but the cost of producing an acre of beets is greater than the cost of producing an acre of wheat. It is probable that most farmers will grow only a small acreage of sugar beets in combination or rotation with other crops. To maintain a production that can be economically handled, it will be necessary to keep the soil in a good state of fertility by means of crop rotation and the application of manure. Sugar beets are best adapted to the medium heavy silty clay loams of the Harlem and Havre series and Havre loam.

Certified seed potatoes constitute another specialized crop that is being grown by a few farmers with considerable success, but cash returns are variable. Ordinarily the yield of certified seed potatoes may be somewhat lower than the yield of the commercial crop, because of the necessity for restricting the size of the potatoes to 12 ounces and the necessity for roguing out diseased plants. Where little roguing is necessary higher yields are often obtained. With good seed planted in fertile loamy soil and the use of good tillage methods, yields ranging from 300 to 400 bushels an acre are not uncommon. Certified seed potatoes are grown to supply the seed trade of the Southern States. The best-quality potatoes are produced on the well-drained loamy soils. Scab development is most serious where potatoes are grown on soils containing considerable alkali.

Spring wheat is still grown on a large acreage of irrigable land within the valley. It has been the most important cash crop grown and probably will continue to be of considerable importance. With the introduction of sugar beets in a more diversified system of farming and an increase in the number of livestock, a large part of the wheat acreage and some additional land will be devoted to the production of feed grains, such as barley and oats.

In 1928 more than 7,000 acres were devoted to wheat, with an average production of 20 bushels an acre. With good seed and proper tillage methods, maximum acre yields of 50 bushels have been obtained. As a rule it is not necessary to irrigate wheat more than once, usually about the time it is heading. A large part of the wheat is shipped direct to St. Paul and some is purchased by local millers.

Alfalfa is the most important forage crop grown on the irrigated lands, the acreage being larger than that of spring wheat. Yields ranging from 2 to 4 tons an acre are obtained. Alfalfa hay is largely fed locally by stockmen, as winter feed for cattle or sheep. The growing of alfalfa in the Milk River Valley is also important as a means of soil improvement, as this plant adds nitrogen to, and improves the physical condition of, the heavier soils. Common, Grimm, and Cossack alfalfa are raised for the production of seed, but the yields have been variable.

Although sweetclover has attained only slight importance in the agriculture of the valley, it is a crop that fits in a rotation better than alfalfa and can be grown on soils having a fairly high alkali content. It is used for pasture or is cut for hay.

Bluejoint is still grown for hay on a comparatively large acreage, particularly on the heavy gumbo soils which are difficult to plow. Where the land can be flood irrigated, fair yields are obtained. Many of the older stockmen prefer bluejoint hay to alfalfa for feeding purposes.

A small acreage of corn is grown nearly every year, primarily for hogging off in the fall. The early maturing varieties, such as northwestern dent and the flint varieties, are commonly grown.

Oats, barley, and rye are grown with considerable success, though on a small acreage. They are grown primarily for grain to be fed on the farm or as nurse crops in starting alfalfa. With an increase of livestock on the farms larger acreages of the feed-grain crops might well be grown. Barley and rye have proved to be excellent feed for hogs.

The acreage of flax differs considerably from year to year. Most of the flax is grown on newly broken land, and the yields are variable.

Most farmers provide a small area near the homestead for garden vegetables, such as potatoes, radishes, onions, lettuce, spinach, carrots, beets, turnips, and cabbage, all of which can be produced successfully.

The surface relief of the Milk River Valley lands is, in general, level and has no appreciable influence on the crops grown. For best irrigation practices, however, the land in many places needs considerable leveling, especially for such crops as sugar beets and potatoes. The different soil types are given some recognition in their adaptation to the various crops grown. The heavy gumbo soils are used either to grow the native bluejoint grass for hay, or they may be sown to alfalfa in order to avoid frequent plowing. Most of the sugar beets and potatoes are grown on the medium-heavy or lighter-textured loams. Alfalfa is grown on nearly all soils that are fairly well drained.

No systematic soil and crop management practices have been followed up to the present time. Until the last two or three years most of the farmers have alternated grain crops with alfalfa. Al-

falfa is grown for a number of years, or as long as the stand remains good, and it is then plowed under and the land planted to a grain crop which may occupy the same field for a number of years. The introduction of sugar beets and potatoes is gradually bringing about better farming methods through the use of more systematic crop rotations and the more extensive use of barnyard manure. More land is being fall plowed at the present time than in years past. The fall-plowed land is disked and harrowed as early in the spring as possible, in preparation for spring wheat, sugar beets, potatoes, or corn. A firm seed bed is especially desirable for sugar beets. In addition to hoeing and thinning, from four to six cultivations are given the beet crop.

The local farm labor supply is usually adequate except during the harvesting season. Labor for threshing is generally supplied by itinerant crews who move westward as harvesting progresses throughout the wheat belt. Sugar-beet workers are largely Mexicans brought in by the sugar company.

An inventory of the numbers of livestock on farms of the Milk River project (including the Chinook division) on December 31, 1928, showed 2,535 horses, 25 mules, 5,764 beef cattle, 56,833 sheep, 2,759 hogs, 433 brood sows, 24,610 fowls, and 152 hives of bees.

It is generally believed by those interested in agriculture that the numbers of livestock could and should be increased, as many farmers keep practically none. A few farmers who control large acreages of land plan to feed either cattle or sheep during the winter on sugar-beet tops and alfalfa. Many farmers keep a few hogs, and practically every farmer keeps a small flock of poultry. Dairying is carried on locally near the towns. Creameries are operated at Glasgow, Malta, Chinook, and Havre, and some cream is shipped to Great Falls.

Some fine modern rural homes have been established in the Milk River Valley, but many more are needed, as many farms have practically no buildings on them. Barns and sheds for the housing of livestock are inadequate, and many prospective settlers are not able to finance a building program. Although most farmers have practically all types of modern machinery, such as tractors, mowers, binders, and some combine harvesters, as well as numerous tillage implements, very few have adequate sheds, and much of the farm machinery remains out of doors the year round. Farmers who do not depend on tractors for power usually keep from three to eight work horses.

SOIL SERIES AND TYPES

In the construction and preparation of the soil map, the different types of soil are charted as the examination and identification proceeds in the field. Where base maps, such as the United States Geological Survey topographic maps, are available the soils are charted directly on them, but where no accurate base maps are available, the soil maps must be constructed as the survey progresses. Ordinarily, in detailed surveys, maps are constructed on a scale of 1 inch to 1 mile, though when greater detail is desirable a larger scale is used. Physical and cultural features, such as roads, railroads,

streams, irrigation canals, towns, schools, churches, and other buildings, are also shown on the soil map.

In the classification of soils for mapping they are grouped according to the characteristics observed when examined in road cuts, ditches, and coulees; by boring holes in the ground; or by digging trenches for the purpose of examination. The most important characteristics that determine the broader grouping of soils into series are as follows: (1) The number and arrangement of layers or horizons in the soil profile; (2) the color of the various layers or horizons, especially of the surface layers; (3) the structure of each layer or horizon; (4) the thickness of the layers or horizons; (5) the composition of the layers or horizons; and (6) the character and origin of the underlying unweathered material. A soil series may be further defined as including soils having similar fundamental characteristics such as depth, color, structure, organic-matter content, reaction to acid, and carbonate content of the different layers of the profile.

The texture, whether sand, silt, loam, or clay, is an important agricultural feature, particularly the texture of the surface soil, and on the basis of texture, the individual soil types are differentiated.

The several natural layers or horizons of a vertical section from the surface downward are collectively termed the soil profile.

The surface soils of members of the Havre series are grayish brown, dark grayish brown, or dark olive brown. The upper part of the subsoil to a depth of 12 inches, is dark grayish brown, firm, and in places slightly columnar. This layer is underlain by stratified sands or mixed sand and gravel. Lime may occur at or near the surface and downward throughout the soil profile. These soils, which are developed over recent alluvium, occur in low flood plains and are in part poorly drained.

The soils of the Harlem series are characterized by heavy dark grayish-brown or almost black surface soils underlain by lighter-colored and lighter-textured material. The surface soil contains little or no lime, but the subsoil is calcareous, the lime being finely divided and well distributed. The upper heavier layers are somewhat columnar. These soils occur on the first bottoms and are subject to overflow. In places surface drainage is inadequate.

The soils of this series differ from the soils of the Havre series principally in their darker color. They bear the same relation to the Havre soils as do the Cass soils to the Sarpy soils. They differ from the Cass soils, which occur farther east, in having, in many places, a tough somewhat columnar layer which shows the effects of alkali.

The surface soils of members of the Bowdoin series are dark grayish brown or dark olive brown and usually extremely heavy in texture. The dark color is not entirely a soil characteristic but is largely residual from the parent material, a dark-colored shale. These soils are plastic and sticky when wet. There is little change downward to a depth of 30 inches, except in the color which becomes slightly lighter. In most places the surface soils are not calcareous, but lime may be present below a depth of 12 inches and is abundant below a depth of 36 inches. These soils are developed on recent

alluvium and occur on the lower stream bottoms. On account of both the position of the areas and the texture of the soil material, drainage is slow. Soils of this series correspond to soils of the Orman series on the terraces, as both owe important characteristics to shale parent material.

The surface layer of the soils of the Beaverton series consists of about 2 inches of grayish-brown or dark grayish-brown loose mulchlike sandy or silty material, underlain to a depth of 6 inches by a dark grayish-brown or brown firm layer which in many places is slightly columnar. The next lower layer is dark brown or rich brown, is slightly compact, and is heavier in texture than the layers above. Below a depth of 16 inches is highly calcareous semicemented sand and gravel, in which a distinct lime accumulation is common in the upper 12 or 15 inches. These soils have developed over alluvial deposits and occur on high well-drained terraces.

The surface layer of the Scobey soils to a depth of 1 or 2 inches is loose grayish-brown mulchlike material. The next lower layer, extending to a depth of 6 or 7 inches below the surface, is dark brown and consists of material which may be coarsely granular but in most places is only cloddy. This layer is underlain to a depth of 12 or 14 inches by a brown or dark grayish-brown layer which is heavier in texture and more compact than the layers above and in most places has a columnar structure. As a rule a zone of lime accumulation consisting of 12 or more inches of loose and structureless highly calcareous material, light grayish brown in color and streaked and specked with white lime, is immediately under the heavy layer. The parent material is calcareous glacial drift.

The characteristic layers of the Phillips soils are as follows: (1) A gray, loose, structureless, deflocculated mulch containing a large proportion of very fine sand and silt; (2) a grayish-brown or dark grayish-brown layer in which the material is slightly more coherent than in the surface layer; (3) a rich-brown or chestnut-brown heavy tough, columnar clay, or solonetz; (4) a zone of carbonate accumulation, in most places lying from 15 to 20 inches below the surface and consisting of grayish-brown friable material with white streaks and spots of lime; and (5) the parent material which, in most places, is glacial drift. Numerous "slick spots" characterize these soils. Low areas, bare of vegetation, occur where the loose deflocculated layer has been removed by the wind, and the heavy solonetz is exposed.

The Marias soils are characterized by a dark grayish-brown loose surface mulch, 2 inches thick, underlain by a 5 to 8 inch layer of dark grayish-brown rather compact material which, in turn, is underlain by a grayish-brown or olive-brown compact claypan, in places indistinctly columnar. Below a depth of 32 inches the color of the soil material is dark gray, streaked and flecked with white-salt accumulations. These soils occur on flats and gentle colluvial slopes. They are developed over either thin glacial drift or colluvial material, the greater part of which is shale. These soils differ from the Orman soils in being more deeply weathered and in being less influenced by shale.

The surface soils of soils of the Orman series are grayish brown, the subsoils are brown or yellowish brown, and both surface soils and subsoils have the olive tinge characteristic of the Orman soils. These soils occur on terraces and colluvial slopes within or border-

ing exposures of shale, and the soil material consists mainly of sediments from the shale. The soils are sticky when wet and bake hard when dry.

In subsequent pages of this report the soils of the Milk River area are described in detail and their locations are indicated on the soil map. The soils are discussed in relation to their limitations and their adaptations for the production of the various crops suited to the region. The best agricultural methods for handling the different soils are given, so far as practice or experimental evidence has proved them to be satisfactory. The acreage and proportionate extent of the soils of the area are given in Table 9.

TABLE 9.—*Acreage and proportionate extent of soils mapped in the Milk River area, Montana*

Soil type	Acres	Per cent	Soil type	Acres	Per cent
Havre loam	60,672	9 7	Scobey fine sandy loam	26,816	4.3
Havre fine sandy loam	17,344	2.0	Scobey clay loam	5,440	.9
Alkali phase	256		Scobey gravelly loam	64,320	10 3
Havre silt loam	13,568	2.2	Scobey stony loam	10,496	1 7
Havre silty clay loam	19,712	3 1	Phillips loam	7,040	1 1
Harlem silty clay loam	33,472	5 4	Marias clay loam	20,224	3.7
Harlem clay	31,360	5.0	Rolling phase	2,432	
Bowdoin clay	96,512	15 5	Poorly drained phase	512	
Bowdoin silty clay	15,616	2.5	Orman clay loam	15,808	2.5
Beaverton loam	2,368	4	Rough broken land	89,664	14 4
Beaverton fine sandy loam	3,200	.9	River wash	32,064	5.1
Colluvial phase	2,240				
Beaverton gravelly loam	2,240	.4	Total	624,000	......
Scobey loam	41,536	8 0			
Shallow phase	9,088				

HAVRE LOAM

Havre loam is mapped throughout the Milk River area, largely along the river valley and the channels of the smaller streams entering the valley. It also occurs as outwash from the streams, located at their junction with, or point of entrance to, the valley.

In virgin areas the upper layer of the surface soil to a depth of 4 or 5 inches consists of a surface mulch of grayish-brown or dark grayish-brown fine sandy loam underlain by brown or dark grayish-brown slightly cloddy and somewhat columnar loam. The upper part of the surface soil does not effervesce when treated with acid, indicating little or no free lime. The second layer of the surface soil, between depths of 5 and 15 inches, is dark grayish-brown loam or very fine sandy loam, which is slightly compact and faintly columnar in places but which crumbles readily on being broken out with a spade. It is distinctly calcareous though no lime concentration is evident. Below a depth of 12 or 15 inches the subsoil is grayish-brown fine sandy loam containing some rust-brown mottlings. The subsoil also is calcareous and consists of stratified layers of different grades of sand.

The foregoing is a description of the dominant profile throughout the areas mapped as Havre loam, but as this is an alluvial soil which has been deposited by flood waters of the streams draining different parts of the adjacent country it is natural to find many slight variations throughout the area. Where this soil borders Havre fine sandy loam a higher proportion of sand occurs in the surface soil, and where

it borders the heavier soils and occurs in slight depressions the surface soil contains a higher proportion of the finer soil particles, giving it a slightly heavier texture. Stratified layers of different-sized soil particles may occur at almost any depth, but stratified clay layers rarely occur except within areas of heavy soil.

A heavy-subsoil variation of Havre loam occurs in numerous scattered small areas in Valley County. In these areas a clay layer, similar to that in Bowdoin clay, occurs at a depth ranging from 18 to 24 inches below the surface. Areas of this variation usually border areas of Bowdoin clay. Numerous floods have deposited the lighter-textured material over former clay areas.

Havre loam occupies a larger acreage in the western part of the valley, particularly in Blaine County and in the western part of Phillips County, than elsewhere in the area. In general this soil occurs at a slightly higher elevation than the adjoining heavier soils, and areas bordering the river channel lie from 5 to 15 feet above the low-water mark. Because of the open and porous character of the soil it is naturally well drained except in areas where a high water table may exist during floods. The surface relief ranges from rather level to hummocky and ridged, and some areas need leveling for best results from irrigation.

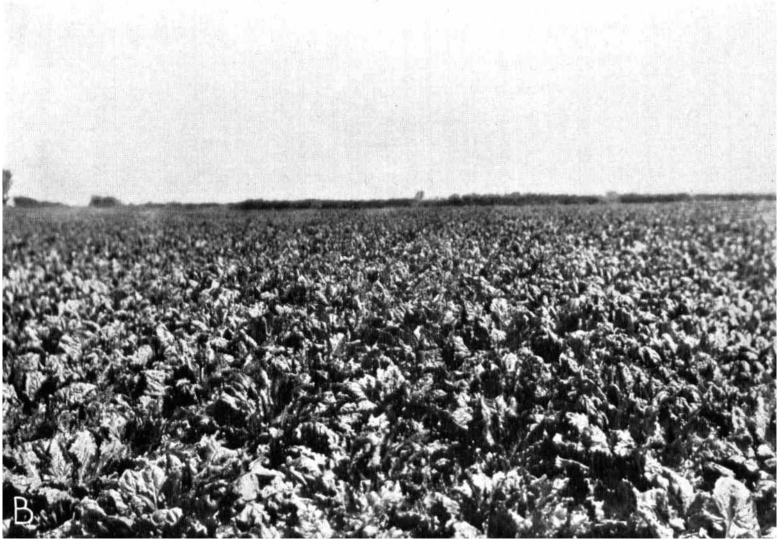
Because of the excellent physical character of this soil it is easily worked, holds moisture fairly well, and warms up early in the spring. It is especially desirable for growing such special crops as sugar beets and potatoes (pl. 1, A), and excellent crops of alfalfa are produced. Although the organic-matter and nitrogen contents are rather low, the soil may be easily and quickly built up by applying barnyard manure and by growing legumes, such as sweetclover and alfalfa. Acre yields of 200 bushels of potatoes are common, although yields as high as 500 bushels have been obtained. Acre yields ranging from 15 to 18 tons of sugar beets have been obtained, but the average yield for the Milk River project as a whole is 9.5 tons. Alfalfa yields from 2 to 4 tons an acre. Grain yields are variable, depending on the care given both the soil and the crops and on whether the land is irrigated or not. Good seed also makes a great difference in the yield obtained.

At the time of the survey (1928) probably not more than one-half of this soil was actually being farmed in a system of diversified agriculture. Much of it was lying idle or was used only for pasture. Because of its adaptability to a system of diversified farming, which includes the growing of grains and legumes, this should be one of the first soils to be developed.

HAVRE FINE SANDY LOAM

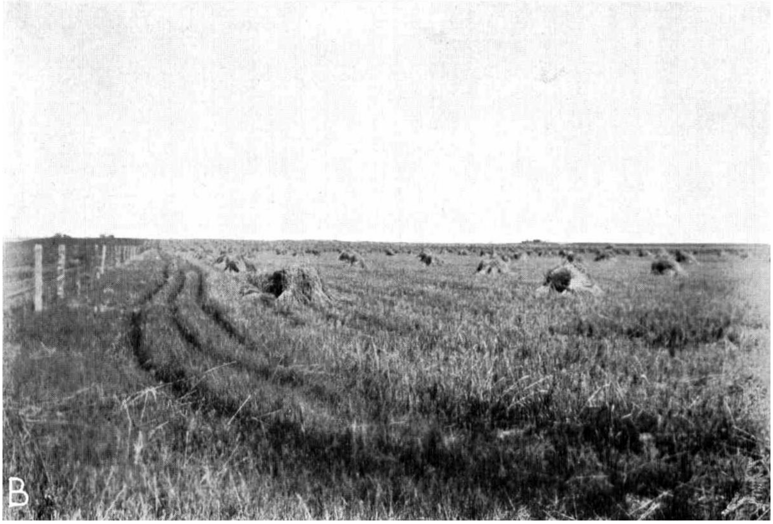
Havre fine sandy loam is similar in appearance and essential characteristics to Havre loam, with which it is associated, but the surface soil contains a higher proportion of sandy material. A profile description of a typical area is as follows: From 0 to 2 inches, dark grayish-brown loam or fine sandy loam, which forms a fine granular slightly laminated organic mulch; from 2 to 7 inches, dark grayish-brown fine sandy loam, slightly compact, faintly columnar, and calcareous; and from 7 to 40 inches; grayish-brown fine sand or very fine sand, faintly stratified and slightly calcareous. This

Certified Bliss Triumph seed potatoes on Havre loam



A promising crop of sugar beets on Harlem silty clay loam

Bluejoint hayfield on Rock Creek project east of Hinsdale



Wheat field on Marias clay loam on Saco bench

soil occurs largely bordering the channel of the river and in its bends, in association with Havre loam, the two soils merging into each other in many places. Although Havre fine sandy loam is rather light in texture and rather low in organic-matter content, it is easily handled and responds readily to good treatment. By the liberal application of manure and the growing of legume crops, the organic-matter content may be increased and yields comparable to those produced on Havre loam may be obtained.

Grama and some scattered valley sage comprise the principal vegetation on virgin areas, and cottonwood trees and buck brush grow along the borders of the river channel where the land is more moist.

A large proportion of Havre fine sandy loam has not been placed under cultivation, largely because of the lack of settlers. However, much of the land is subject to overflow during times of high water, and in many places it needs leveling for proper irrigation. In combination with the heavier soils it should fit well in a system of diversified agriculture.

Havre fine sandy loam, alkali phase.—Havre fine sandy loam, alkali phase, is a poorly drained alkaline soil. Except for the effects produced by these conditions it is similar to typical Havre fine sandy loam. Only a few areas are mapped, the principal one being about 1 mile east of Exeter. This soil is apparently an outwash deposit which has become seeped and on which considerable white alkali has accumulated. The distribution of the white salts at the surface and through the soil produces a light color. The vegetation is largely salt grass.

The surface soil is brownish-gray loam or fine sandy loam, from 6 to 10 inches thick. Below this the soil material becomes distinctly moist and is gray fine sandy loam which continues to an undetermined depth. In its present condition, the soil is nonagricultural, except for the scant pasture it affords. If it were drained, it is possible that the land might be reclaimed and brought under cultivation, but at present land values it is doubtful whether this would be profitable. Most of this soil lies above the irrigation canal.

HAVRE SILT LOAM

Havre silt loam is similar in profile characteristics to Havre loam and Havre fine sandy loam, but the surface soil is finer in texture. Most of the silt loam areas are associated with Havre loam and with the heavier and darker-colored soils of the valley. Havre silt loam is not so extensive as Havre loam, and it occurs in isolated areas throughout the valley. It occupies slightly lower positions than the more sandy soils. West of Chinook and east of Lohman, drainage is somewhat restricted in places. During and after floods, resulting from the overflow of Milk River and Redrock Coulee, water may stand on the land for some time.

Southwest of Wagner is an area in which the soil profile differs from the normal profile of the Havre soils. Here the soil to a depth of 8 inches is grayish-brown or dark grayish-brown mellow or floury silt loam which is slightly calcareous and slightly mottled with rust-brown material.

In general Havre silt loam in Phillips County is slightly heavier and in more places has a heavier stratified layer beneath the surface soil than areas of this soil mapped in Blaine County. The areas in Blaine County are much larger and have a silty surface soil which grades into brown loam at a depth of 6 or 8 inches, and the subsoil and substratum consist of very fine sandy loam.

All the crops commonly grown in the valley may be produced on Havre silt loam. Ordinarily drainage is not a factor, though in rainy seasons or during floods alfalfa may be killed. Sugar beets or potatoes generally occupy from 10 to 20 acres on each farm. As in other soils of the Havre series, the organic-matter and humus content should be constantly replenished by the systematic use of manure and leguminous crops, in order that yields may be materially increased and the fertility may be at least partly maintained.

HAVRE SILTY CLAY LOAM

Havre silty clay loam is the heaviest member of the Havre series mapped in this area and ranks as one of the medium heavy soils of the valley. Only a few isolated areas are mapped west of Malta, but bordering Beaver Creek and along Milk River in eastern Phillips and Valley Counties a rather large acreage is mapped.

The profile of an area west of Coburg shows the following layers: From 0 to 6 inches, dark olive-gray cloddy columnar noncalcareous silty clay; from 6 to 15 inches, dark olive-brown calcareous somewhat laminated or stratified silty clay loam; and from 15 to 40 inches, dark grayish-brown very fine sand containing some brown mottlings.

In the valley of Beaver Creek and also in the Milk River Valley north of Saco and extending east to Glasgow and Nashua, this soil is in many places associated with the heavier Bowdoin clay and grades into that soil rather imperceptibly. These areas differ from the profile described in that the surface soil is dark grayish-brown heavy silty clay, very plastic when wet and hard and compact when dry, which may be slightly calcareous. The underlying soil material is brown or dark-brown columnar silty clay. The subsoil and substratum range from brown heavy loam to very fine sandy loam. Here the lighter-textured material occurs at a greater depth than in the areas mapped west of Malta.

The porosity, physical condition, and drainage of Havre silty clay loam are much better than those of the Bowdoin soils, and the soil is inherently fertile and fairly well drained but is somewhat more difficult to handle than other soils of the Havre series. In some places it is farmed in conjunction with the adjoining soils. Grain, alfalfa, and bluejoint hay are the principal crops grown at the present time.

HARLEM SILTY CLAY LOAM

The surface soil of Harlem silty clay loam consists of very dark grayish-brown or dark olive-brown silty clay loam which may range in depth from 4 to 12 inches. When dry the material is more or less cloddy and at the greater depths is somewhat columnar in structure. In most places the surface soil grades into dark-brown slightly calcareous loam, though the change from the dark-colored surface soil may be abrupt and the material may pass directly into light

brownish-gray very fine sandy loam which is more or less stratified and distinctly calcareous. As in soils of the Havre series, changes in texture from the surface downward may vary considerably, depending on the time of the floods and the amount of material deposited. The lack of free lime in the dark-colored surface soil is probably due to the lack of lime in the original material rather than to leaching, as the residual shales in the area are known to contain but little lime.

The principal occurrence of this soil is back from the major stream courses, at a slightly lower elevation than the lighter-colored and light-textured Havre soils. The larger areas are in the vicinity of Chinook, south of Zurich, in the vicinity of Harlem, and northeast of Hinsdale. Smaller areas occur throughout the upper part of the Milk River Valley.

In places, particularly near the place where Redrock Coulee enters the valley and east of Chinook, Harlem silty clay loam is in need of surface drainage, especially in the spring, when floods occur, or during the rainy season. A number of depressions and old stream courses are in the areas occupied by this soil, particularly east of Chinook. These cut the land to a great extent and make it necessary to cultivate many irregular fields.

Agriculturally Harlem silty clay loam is one of the important soils of the upper part of the Milk River Valley. Its darker color indicates a higher organic-matter and nitrogen content than is found in the Havre soils. This soil, together with the soils of the Havre series, comprises the most important group of irrigated soils because of their possibilities of development.

A large acreage of this soil is devoted to the production of alfalfa, grain, and sugar beets (pl. 1, B), and areas that have not been broken still support a growth of the native bluejoint (*Agropyron smithii*) which is either cut for hay or is used for pasture. (Pl. 2, A.) On fairly well-drained areas alfalfa yields from 2 to 4 tons an acre, wheat yields average between 15 and 20 bushels, and sugar beets normally yield from 10 to 14 tons, though higher yields have been obtained on well-prepared ground.

HARLEM CLAY

Harlem clay is locally termed "gumbo." The larger areas occur south and southeast of Coburg, southwest of Savoy, south and east of Harlem, east of Hinsdale, and west of Glasgow, and small areas are scattered throughout the valley.

This soil consists of dark-gray or dark-brown very heavy plastic clay to a depth which varies to a rather large extent. In some places fine sandy loam is reached at a depth of 10 or 12 inches, but in most places the clay ranges from 15 to 30 inches in depth, below which is the lighter-textured material. When thoroughly dry, the soil cracks considerably, is cloddy, and more or less columnar. At a depth ranging from 15 to 18 inches the soil in many places is flecked with white salt accumulations which may or may not effervesce with acid. The deep heavy gumbo topsoil grades into mottled brown and gray calcareous clay loam at a depth ranging from 20 to 27 inches. Below a depth ranging from 30 to 36 inches gray calcareous fine sandy loam occurs in most places. In general the location or position of this soil does not allow adequate surface drainage during wet seasons.

Most areas of Harlem clay are very deep. With the exception of comparatively small areas, none of this soil has been broken for farming purposes, but it remains in its native bluejoint sod. Where the land can be flood irrigated, yields ranging from three-fourths ton to 2 tons of bluejoint hay are produced. This hay is generally in demand and at times commands a price equal to that obtained for alfalfa, as many of the older stockmen prefer it to alfalfa for feeding livestock.

Because of the comparatively large acreage of Harlem clay and the difficulties in handling the land, this soil presents a serious problem in the further agricultural development of the Milk River Valley. Surface drainage and protection from flood waters are necessary in some places, as when the land is flooded, water stands on the surface for a long time, because the relief does not allow natural run-off and percolation of water through the soil is very slow. It is believed that, in areas having fair surface drainage, much of this heavy land might be gradually broken and seeded to deep-rooting legumes, such as sweetclover and alfalfa. Farmers who cultivate farms including some of the lighter-textured soils might well use a rotation scheme on soils which are easily worked and use the heavier soils for the production of forage crops, so that feed for the farm livestock could be supplied. Special crops, such as sugar beets and potatoes, should not be grown on the heavy cold gumbo soils until they are somewhat improved in tilth.

Table 10 gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of Harlem clay.

TABLE 10.—*Mechanical analyses of Harlem clay*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
470520	Surface soil, 0 to 27 inches	0 0	0.1	0.2	0.6	2.2	16.6	80.3
470521	Subsurface soil, 27 to 36 inches	0	.2	.1	.6	5.3	34	59.8
470522	Subsoil, 36 to 50 inches	0	.1	.1	.3	12.2	58	29.3

BOWDOIN CLAY

Bowdoin clay is another gumbo soil which is similar to, and occupies the same relative position in the valley as, Harlem clay. Bowdoin clay differs from Harlem clay in that it is lighter colored and in most places contains a higher proportion of alkali. A rather typical profile of an area of this soil in sec. 22, T. 30 N., R. 29 E., is as follows: From 0 to 6 inches, grayish-brown massive cloddy noncalcareous clay, the surface soil of which shows wide cracks when dry; from 6 to 18 inches, grayish-brown or gray faintly columnar clay which breaks into very hard clods when dry and contains some salt mottlings; from 18 to 36 inches, light-gray clay profusely mottled with white salt accumulations and some rust-brown stains, some of the salt accumulations being slightly calcareous; and from 36 to 60 inches, light brownish-gray distinctly calcareous very fine sandy loam.

The surface soil is developed from outwash material of the shale formations that outcrop in the breaks bordering the valley. In general this soil is rather uniform in physical characteristics, but a number of variations exist. In places the clay is 48 inches deep, or deeper, and has no sandy substratum, and in other areas a sandy substratum may occur at a depth ranging from 24 to 30 inches. South of Zurich in the region of the Cook Reservoir, Bowdoin clay is rather poorly drained and also rather alkaline, and in this area drainage is a factor that must be considered before agricultural development can take place. Other areas having a fairly high alkali salt content are west and north of Malta, near Lake Bowdoin, and northwest of Hinsdale bordering Beaver Creek.

An included phase of Bowdoin clay consists of gray or dark-gray hummocky land which is characterized by its tendency toward "slick spots" and the presence of scattered greasewood as an important part of the vegetation. The gray or dark-gray heavy surface soil is underlain by layers of fine sandy loam. Most areas of this soil lie at slightly higher elevations than either the typical Bowdoin soils or the Harlem soils, and in some places the soil occurs on low colluvial slopes bordering the uplands. The surface soil and upper subsoil material are in most places noncalcareous.

Bare areas of this soil just west of Wayne Creek have a thin gray alkaline crust on the surface, and to a depth of 5 inches the soil is dark-gray noncalcareous clay loam which passes into noncalcareous grayish-brown clay having no distinct structure. Near the mouth of Alkali Creek and elsewhere west of Malta the surface relief of the soil is very hummocky, and here the vegetation includes a large amount of greasewood. The soil consists of gray or dark-gray clay, or clay loam, which is streaked with alkali-salt accumulations at a depth ranging from 10 to 15 inches, and, at a depth of 18 or 20 inches, this heavy material passes into calcareous very fine sandy loam. Other areas of this included soil occur south of Lake Bowdoin, bordering the valley of Beaver Creek from Ashfield southward past Woolridge, and a large seeped and alkaline area is about 2 miles east of Beaverton.

Large areas of Bowdoin clay are subject to overflow and standing water, which in some places seriously limit the agricultural use of the land under present economic conditions. The valley of Beaver Creek and the region surrounding Saco are more or less subject to standing water during wet seasons. In order to correct this condition it has been proposed to divert the waters of Beaver Creek into Milk River about 2 miles east of the Nelson Reservoir by cutting through the low divide at this point.

The dominant vegetation on undisturbed areas of Bowdoin clay is bluejoint, and scattered greasewood shrubs grow on the more alkaline areas. On areas that can be flood irrigated, fairly large yields of hay are obtained. In times past these areas were largely under the control of stockmen who utilized them for the production of winter feed.

Comparatively small areas of this heavy land have been broken for the production of farm crops. The areas in the vicinity of Glasgow are better developed, agriculturally, than elsewhere. If flood waters and drainage can be fairly well controlled, little dif-

ficulty should be experienced in obtaining a stand of sweetclover or alfalfa, but in places where there is considerable seepage and a concentration of alkali salts, it may be very difficult to grow either of these crops, and the feasibility of drainage must then be considered.

The agricultural development and use of this heavy soil must of necessity be rather slow and will take place only as the need for additional land increases. The most immediate utilization of the land probably should be the production of forage crops and, perhaps, some small grain. As rather extensive areas of the more easily handled lighter types of soil are available, it is not recommended that the growing of such crops as sugar beets or potatoes be attempted on this heavy soil until it has been somewhat improved in tilth.

This is the most extensive soil in the valley, but it is undesirable because of its physical character.

Table 11 gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of typical Bowdoin clay.

TABLE 11.—*Mechanical analyses of Bowdoin clay*

No	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
470523	Surface soil, 0 to 28 inches	0.1	0.1	0.0	0.1	0.6	18.4	80.7
470524	Subsurface soil, 28 to 36 inches	0	.1	.1	.5	2.9	28.1	68.4
470525	Subsoil, 36 to 52 inches	0	0	0	1.1	11.9	45.8	41.1

BOWDOIN SILTY CLAY

Bowdoin silty clay is associated with Bowdoin clay and is similar to that soil in all respects except that the surface soil of the silty clay has a better physical structure and is somewhat lighter in texture. Bowdoin silty clay occupies somewhat more favorable positions than Bowdoin clay and is less subject to standing water. Agriculturally it is more desirable, though of less extent than the clay. Bluejoint hay, alfalfa, and grain are the principal crops.

BEAVERTON LOAM

A typical area of Beaverton loam is east of the Nelson Reservoir. The areas east of Dodson have subsoils somewhat heavier than the typical subsoil.

A sample taken about 1¾ miles east of the reservoir in sec. 19, T. 32 N., R. 33 E., shows the following profile characteristics: From 0 to 2 inches, a grayish-brown fine sandy loam surface mulch; from 2 to 6 inches, brown slightly columnar noncalcareous loam; from 6 to 16 inches, chocolate-brown columnar noncalcareous silty clay loam; from 16 to 30 inches, a gray semicemented fine sand and gravelly calcareous zone; from 30 to 42 inches, gray stratified fine sand streaked with lime; and from 42 to 54 inches, yellowish-brown stratified fine sand and gravel.

In many respects this soil is similar to Scobey loam, which is mapped in the uplands, but the underlying layers show rather dis-

tinct stratification and the relief is that of a rather level bench in what probably was a former stream channel. Agriculturally the soil is similar to Scobey loam. Its physical condition, porosity, and drainage make it satisfactory for growing any crops adapted to this general region.

BEAVERTON FINE SANDY LOAM

Areas of Beaverton fine sandy loam border Whitewater Creek northwest of Saco, and one area is 2 miles east of Beaverton. These areas occur as distinct benches lying several feet above the valley floor and above normal overflow.

The profile characteristics of this soil are essentially the same as those described for Beaverton loam except that the texture is distinctly sandy, the color is lighter brown, and leaching has taken place to a somewhat greater depth, as the calcareous zone occurs at a depth ranging from 20 to 24 inches below the surface. Stratified sand and gravel occur at the lower depth.

A variation of this soil occurs north and east of Lohman and east of Dodson. It differs from the typical soil in the absence of gravel in both surface soil and subsoil. Between depths of 20 and 34 inches the subsoil is distinctly calcareous structureless light grayish-brown fine sandy loam which, below a depth of 34 inches, passes into gray fine sandy loam containing gravel slightly cemented with lime. Below a depth of 40 inches the substratum contains less lime and is brown. Land of this kind is largely nonirrigated, and most of it remains covered with the natural vegetation. The physical structure of the soil renders it excellent for irrigation, but its location above the high line canal precludes this unless pumping operations could be established.

The area bordering Whitewater Creek is not irrigated but is dry farmed, wheat being the principal crop. Because of its light texture this soil is not favorable to the retention of moisture, and it is subject to blowing. The area east of Beaverton is irrigable, and here the moisture content can be controlled and soil blowing largely eliminated. Although the nitrogen content of the soil is low it may be easily built up through the application of manure and the growing of legumes. Alfalfa does well, and potatoes and sugar beets can be grown.

Beaverton fine sandy loam, colluvial phase.—A number of isolated areas of the colluvial phase of Beaverton fine sandy loam are mapped in the Milk River area. Soil of this phase occupies colluvial slopes between the breaks and the valley floor. The colluvial soil material has accumulated more largely from the sandstones than from the shales, and much of it is calcareous at or near the surface.

The surface layer to a depth ranging from 2 to 4 inches is brownish-gray fine sandy loam which is underlain by a layer of calcareous light-brown somewhat heavier fine sandy loam or loam. This layer grades into yellow or buff fine sandy loam. Most of the areas mapped are free from sandstone or other rock fragments. None of the land is farmed as it is nonirrigable, the texture being too coarse and the soil having poor moisture-holding capacity. The vegetation, consisting of grama, white sage, nigger wool, and feather grass, is rather thin. In most places this land is used, in conjunction with the rougher areas, for grazing.

BEAVERTON GRAVELLY LOAM

The principal areas of Beaverton gravelly loam border Beaverton loam and Beaverton fine sandy loam areas, east of Nelson Reservoir and near the mouth of the valley of Whitewater Creek. These areas have more or less gravel throughout the soil, and the surface soil ranges from fine sandy loam to loam. The surface, or organic, layer is somewhat shallower than the corresponding layer of the loam or fine sandy loam types, but otherwise the profile characteristics of the three soils are very similar. Because of the large content of gravel, these areas, where irrigated, will probably be used more for the growing of alfalfa than for other crops.

SCOBEY LOAM

Scobey loam covers an extensive area in the uplands of northern Montana. A number of areas of this soil lie near the Milk River Valley between Havre and Nashua and have been included in this survey. This is one of the better soils for wheat growing under dry-land farming practices.

The surface layer consists of about 2 inches of grayish-brown loose friable sandy loam surface mulch. It is underlain to a depth of 7 inches by a layer of dark grayish-brown loam which is firm but not compact and in many places is coarsely granular. The next lower layer, which extends to a depth of about 14 inches, consists of slightly darker loam. The material of this layer, when in position, has a columnar structure, but when dug out the columns break across, forming somewhat cubical clods. Below this layer is the zone of lime concentration, consisting of grayish-brown friable loam or sandy loam, specked and streaked with white lime. This layer grades at a depth of about 30 inches into structureless calcareous glacial drift or into the underlying partly decomposed rock. Glacial bowlders occur on the surface and throughout the soil. In places the second layer described is lacking and the heavy compact layer lies immediately below the surface mulch.

The surface relief of Scobey loam ranges from nearly level and gently sloping to rather billowy and hummocky. Glacial mounds, ridges, and depressions are common features of the landscape. Drainage is not well established in the large tracts of glacial uplands, and many of the depressions hold the spring flood water until it slowly evaporates. In other places the character of the surface soil, which consists of a porous surface layer and a heavier slightly compact subsurface layer, is almost ideal, considered as to its moisture-holding capacity.

Under careful tillage practices, such as maintaining a clean summer fallow at least once in three years, fairly good yields of wheat are obtained in normal seasons. Spring-wheat yields usually average between 15 and 20 bushels an acre, although during extremely dry years the yields may be as low as 5 bushels. Much of the land abandoned during the years of drought (1918–1922) is again (1928) being brought under cultivation.

The vegetation on the glacial upland consists chiefly of grama (*Bouteloua gracilis*) and associated grasses, which provide excellent range forage. Much of the area not under cultivation at present is used for range and this, together with the rolling and broken land

bordering the Milk River Valley, provides a large acreage used entirely for grazing. The contiguity of fairly large areas of this type of land to the valley proper suggests the possibility of a combination of livestock farming with the more specialized irrigation farming in which winter feeds may be easily grown.

Scobey loam, shallow phase.—Scobey loam, shallow phase, is mapped on the lower slopes and flat benches bordering the Milk River Valley and in isolated areas within the valley. This soil is developed where the drift is rather shallow and is variable in composition. The surface soil is dark grayish-brown or brown heavy loam or silty clay loam. It is more or less columnar and very compact and dense below a depth of 3 or 4 inches. The subsurface soil is calcareous at a depth of 7 or 8 inches, though the lime zone in most places is not so distinct as in typical Scobey loam. This grayish-brown compact and heavy material continues to a depth ranging from 15 to 18 inches and below this depth passes into grayish-brown silty clay, in many places mottled with white salt accumulations and rust-brown material. This material, in turn, grades into the mixed glacial drift and the underlying residual formations. In places the surface soil has a tendency toward " slick spots."

The shallow phase differs from typical Scobey loam in having a more shallow surface soil, more compact and dense subsurface layer, and a lighter cover of grass. It is really a transitional soil between Scobey loam and Phillips loam. Not much of the land is under cultivation, but it is used largely for grazing land in conjunction with the bordering rough broken land. Some wheat is grown.

SCOBEY FINE SANDY LOAM

The larger areas of Scobey fine sandy loam are southeast of Lohman, southeast of Chinook, east of Malta, and northeast and northwest of Hinsdale. This soil is coarser and sandier than the other Scobey soils and, because of this, drainage is good or excessive. The surface relief ranges from smooth to gently rolling. This would be considered good land for irrigation were it not that a large part of it lies above the high-line canal. It is good soil, however, and is largely dry farmed.

The organic-matter content and the water-holding capacity of Scobey fine sandy loam are not so high as in the heavier loams. The soil is likely to blow badly once the fibrous roots have been destroyed. The yields of small grains are not so high as yields on the heavier Scobey loam. Because the land warms up earlier in the spring, more corn is grown on this soil than on the heavier soils. Cropping and tillage methods are about the same as on the loam soils.

The following description is considered typical of the profile of this soil: From 0 to 1 inch, dark grayish-brown or brown fine sandy loam, with a very fine granular structure; from 1 to 6 inches, dark grayish-brown slightly compact fine sandy loam containing some rounded pebbles; from 6 to 16 inches, dark-brown heavy fine sandy loam with a slight red tinge, slightly compact and noncalcareous; from 16 to 28 inches, gray calcareous fine sandy loam with a high lime content; and from 28 to 42 inches, brownish-gray slightly calcareous fine sandy loam. The vegetation on this soil is largely grama, with some scattered white sage.

SCOBEY CLAY LOAM

A number of variable soil areas are mapped as Scobey clay loam, the principal ones lying north and west of Chinook, west of Savoy, and northwest of Glasgow.

Northwest of Chinook the surface soil to a depth of 2 inches is a loose grayish-brown organic mulch which quickly passes into dark-brown, rather dense, compact, and faintly columnar, noncalcareous clay loam. At a depth of about 8 or 9 inches the material grades into grayish-brown friable calcareous clay loam. The lime zone is neither well defined nor distinct. At a depth of 19 or 20 inches the material of the calcareous zone grades into gray silty clay which is highly mottled with white salt spots and rust-brown material. At a depth of about 3 feet the substratum is mottled brown loam spotted with salt accumulations. Below this depth the material is more or less laminated or stratified brown fine sandy loam and dark clay loam.

A slightly different profile was noted in an area northwest of Glasgow, which is described as follows: From 0 to 1½ inches, a dark grayish-brown slightly granular loamy mulch; from 1½ to 5 inches, dark-brown noncalcareous clay loam; from 5 to 12 inches, dark-brown noncalcareous columnar clay; from 12 to 26 inches, gray streaked friable calcareous silty clay; and from 26 to 45 inches, brown calcareous heavy loam or sandy clay loam.

The area west of Lohman occupies a fairly large depression and is largely under cultivation, grain alternating with summer fallow, and other areas are used largely as range pasture land.

Table 12 gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of Scobey clay loam.

TABLE 12.—*Mechanical analyses of Scobey clay loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
470533	Surface soil, 0 to 2 inches	0.3	2.5	4.4	11.4	15.7	41.3	24.3
470534	Subsurface soil, 2 to 8 inches	.2	1.3	2.4	5	7.9	33	50.2
470535	Subsoil, 8 to 19 inches	.1	.3	.4	1.5	7.3	43.5	46.8
470536	Subsoil, 19 to 35 inches	.1	.1	.1	1.1	9.3	48.2	41.2
470537	Subsoil, 35 to 45 inches	.1	.3	.8	8.9	23.1	38.4	28.5

SCOBEY GRAVELLY LOAM

Scobey gravelly loam is mapped throughout the uplands bordering the Milk River Valley and in isolated areas within the valley. Those areas occurring largely as broken land are included in the miscellaneous group mapped as rough broken land.

The soil material of Scobey gravelly loam is essentially the same as that mapped as Scobey loam, but the surface layer, which contains most of the organic matter, is usually somewhat shallower and contains considerable gravel ranging in size from pebbles to rocks several inches in diameter. The gravel content makes the soil difficult to plow or cultivate. Most of the land is nonirrigable and is used for grazing. It is possible that seeding of sweetclover on the

better parts of this soil might increase its carrying capacity for livestock.

SCOBEY STONY LOAM

Areas of very stony land, containing numerous large bowlders as well as much small gravel and occurring in the uplands, more particularly northeast of Malta in the so-called "big bend" section, are mapped as Scobey stony loam. These areas are largely remnants of high rolling eroded plateaus where cultivation would be difficult if not impossible. The soil material is similar to that of Scobey loam and Scobey gravelly loam. Under present economic conditions this land must be considered strictly as grazing land.

PHILLIPS LOAM

A number of areas of Phillips loam are mapped, principally in the big bend section northeast of Malta and near the Fort Belknap Indian Reservation boundary line southwest of Harlem. Areas of this soil are characterized by numerous bare spots, locally known as "slick spots," "blow-outs," or "gumbo spots," which differ in size and outline, giving the land a scabby appearance. The spots range from 3 to 8 inches in depth, and most of them are crusted over with light-colored silty material. Below the crust, the soil material is compact loam or clay loam, which grades into a hard compact layer more than 5 inches thick, consisting of plastic heavy loam, the lower part of which is flecked and streaked with lime and alkali. The material of this layer grades into the highly calcareous gray subsoil similar to that occurring in the grass-covered areas. and this, in turn, grades into the structureless drift, or, in many places into mixed shaly material. The soil of the grass-covered areas between the bare spots is much the same as Scobey loam except that the upper subsoil layer is more compact, tending toward a claypan, and the lower subsoil layer and substratum in many places are mixed with the underlying residual material.

Most of this soil occurs within the depressed areas of the glaciated region, where drainage is somewhat retarded. The surface relief is gently rolling or flat. Phillips loam is considered a marginal farming soil in the dry-land areas. The bare spots are difficult to reclaim and are rather unproductive except in years of heavy rainfall. Wheat is the principal crop grown. Much of the land has reverted to range conditions and is used only for pasture.

MARIAS CLAY LOAM

The larger areas of Marias clay loam are mapped on the Saco divide between Milk River and Beaver Creek, south of Nashua between Milk and Missouri Rivers, and southeast of Tampico.

The surface inch or two of soil consists of a dark grayish-brown granular silty clay mulch, in most places highly calcareous. To a depth of 10 inches the soil is dark grayish-brown somewhat columnar and cracked slightly calcareous silty clay. Between depths of 10 and 32 inches the subsoil is olive-gray massive calcareous clay, and this material grades into brown highly calcareous silty clay loam. The substratum is dark-gray silty clay, streaked and flecked with

white salt accumulations. In places a few glacial bowlders are scattered over the surface.

Marias clay loam is one of the important and better-developed nonirrigated agricultural soils in the area. Though rather heavy and difficult to plow, excellent yields of grain have been obtained at times. Wheat yields during the last two or three years have averaged between 20 and 30 bushels. (Pl. 2, B.) Both winter and spring wheat are grown. Continuous cropping has been the general practice, but an increasing acreage of the land is now being summer fallowed, the work being done largely with tractors.

Marias clay loam, rolling phase.—North of Beaverton and south of Tampico a rolling phase of Marias clay loam is mapped. This differs from typical Marias clay loam in that the land is somewhat more rolling (although not too rolling for cultivation), somewhat lighter in texture (in some places approaching a heavy loam), and also lighter in color. Some eroded slopes of this land showed a more distinct lime layer, and in some places the subsoil or substratum is distinctly sandy, whereas the typical soil is distinctly heavy throughout. These rolling areas are farmed in a similar manner as the surrounding soils, wheat being the principal crop.

Marias clay loam, poorly drained phase.—A number of depressed areas within the general region mapped as Marias clay loam are separated as Marias clay loam, poorly drained phase. Most of these poorly drained areas have no drainage outlets and hold water for some time during the spring and following heavy rains. As the soil is very heavy, most of it is uncultivated, being left in grass and used for pasture.

Table 13 gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of typical Marias clay loam.

TABLE 13.—*Mechanical analyses of Marias clay loam*

No	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
470560	Surface soil, 0 to 1 inch	0 1	0 6	1 1	4 8	7 5	27.4	58 4
470561	Subsurface soil, 1 to 10 inches	.2	.6	1.2	4 3	6 7	24.4	62.6
470562	Subsoil, 10 to 32 inches	1	5	9	3.3	5 5	23.6	66.1
470563	Subsoil, 32 to 44 inches	0	.4	.8	3 0	5 2	21 0	68.6
470864	Subsoil, 44 to 54 inches	.1	5	.9	3 5	5 2	18.7	71.1

ORMAN CLAY LOAM

The surface soil of Orman clay loam is dark grayish-brown or olive-brown clay loam or clay to an average depth of 5 inches. When dry the upper inch may be loose and mulchlike or crusted. The subsoil to a depth of 16 inches is olive-brown dense heavy clay loam or silty clay loam, lighter in color than the surface soil and in places approaching a hardpan. Below this is light olive-brown silty clay loam or clay containing white specks and streaks of lime and, in many places, gypsum. Lime may be present in the surface mulch, and in all places it occurs at some depth below 10 inches. The slate or olive color characteristic of this soil is derived from the parent material which consists of sediments brought down from areas of shale. On the higher and steeper slopes, the soil is underlain by

shale at a depth ranging from 1 to 3 feet, but on the flats and gentle slopes the transported material is several feet deep.

Orman clay loam varies in different parts of the area, mainly as a result of differences in composition of the parent material. If the sediments over which the soil developed are composed largely of material washed down from the shale hills, the soil differs little from the soil residual from shale, as it is heavy in texture and changes very slowly into soil. The greater part of the area of this soil is of this character. In places, however, more or less coarser sediment has been brought in with the shale material, such as in the area near Hinsdale which is composed of a considerable amount of material other than shale and as a result has weathered more deeply. Here, the soil is better farming land than other areas of Orman clay loam, and much of it is in cultivation. In some places the soil material contains large amounts of soluble salts which concentrate at the surface and injure vegetation, and in other places there is a tendency toward the formation of a claypan, or hardpan, through the layer affected by alkali salts. Small included areas of this kind are much like the Phillips soils.

The greater part of this soil occupies gentle colluvial slopes and almost flat benches. From the eastern edge of the area, northwestward as far as Glasgow, narrow broken strips occur at the breaks from the upland and extend out on the flat bottoms. A flat southeast of Hinsdale is occupied by this soil, and a number of areas lie along the valley of Beaver Creek and along Milk River as far as Malta.

With the exception of the area near Hinsdale, where fair yields of grain are produced in seasons of well-distributed rainfall, only a small part of the land is cultivated, the greater part being used only for grazing. The livestock-carrying capacity of the grazing land is low, as the soil supports a rather sparse vegetal cover, consisting mainly of western wheatgrass, bluejoint, black sage, and annual weeds.

ROUGH BROKEN LAND

All the broken land or breaks bordering the stream courses is included in a miscellaneous group of soils, rough broken land. This land is entirely untillable, and its only value is for grazing livestock.

Rough broken land includes three classes of soil material—glacial soil, residual shale, and residual sandstone. The breaks bordering Milk River Valley west of Malta are mostly covered with some glacial material. This part of the area probably supports a better grass cover than the breaks farther east, hence it has a somewhat higher grazing value. The breaks north and east of Malta consist largely of eroded shale material which on the whole supports a sparse vegetation, as do the sandstone and shale breaks east and south of the valley of Beaver Creek. Wherever glacial material covers the underlying shale and sandstone formations, better vegetation exists.

RIVER WASH

The miscellaneous soil material bordering the channel, occurring in the bends of Milk River and the old stream channels is mapped as river wash. When the river overflows, the waters deposit sand, silt,

and clay, hence a uniform or permanent soil has not developed. Most of the river wash areas are either forested or covered with brush of various kinds and in some places are more or less swampy. Although this land is not used for agriculture at present, it is possible that the better areas may be cleared, leveled, and used for growing the crops normally adapted to the fine sandy loam and loam soils of the Havre series.

WATER SUPPLY AND IRRIGATION

The irrigation plan of the Milk River project provides for storage of water in Sherburne Lake in Glacier National Park and its diversion through a canal 29 miles long, heading three-fourths of a mile below the lower St. Mary's Lake and discharging into Battle Creek, thus supplementing its natural flow and that of other streams emptying into Milk River. Milk River flows through Canada for 216 miles and then returns to the United States, supplying irrigation water for the lands in the Milk River Valley. Water is diverted from Milk River by dams near Chinook, Harlem, Dodson, and Vandalia.

The irrigation districts of the Chinook division had early water rights on Milk River. Because the natural flow of the river is often low during the summer months, the districts have contracted with the Bureau of Reclamation for the use of additional water. Water for the Fort Belknap Indian Reservation is diverted south of Harlem. Irrigation water is diverted by a dam west of Dodson into two canals. The Dodson north canal supplies water for lands near Dodson and Wagner and north of Malta. The Dodson south canal irrigates lands on the south side of the river near Wagner and Malta and also conveys water to the Nelson Reservoir which provides water for the Saco and Hinsdale territory. Another dam west of Vandalia diverts water into a canal on the south side of the river for the irrigation of lands near Tampico, Paisley, Glasgow, and Nashua.

Water for irrigation is available from about the middle of April to the last of September. Except for the possible irrigation of pasture land, most of the irrigation takes place during June, July, and August. Usually a large part of the seasonal rainfall occurs during April, May, and June, and only occasionally is it necessary to irrigate crops prior to June.

Private irrigation projects are located at the mouths of French man and Rock Creeks, northeast of Saco and Hinsdale, respectively. These projects provide only for diverting the natural flow of the two streams during the spring and early summer when the flow is at its height. This water is used almost entirely for the flooding of hay lands. A canal from Porcupine Creek, east of Nashua, conveys water to the land south and east of Wiota. This canal was built under the direction of the Bureau of Indian Affairs.

RECOMMENDATIONS FOR THE IMPROVEMENT OF THE MILK RIVER AREA SOILS

Of the land now irrigated or which may be irrigated, more than 50 per cent consists of heavy soils. Although the heavy soils are inherently more fertile or contain a higher proportion of total plant food than the lighter-textured soils, they are much more difficult to cultivate and handle. In connection with the utilization of these

heavy soils, flood control and surface drainage must be considered in some areas. The only grass which seems to be able to cope with standing water is the native bluejoint. In some areas the alkali content of the soil is a limiting factor in crop production. Most of the heavy soils, particularly if well drained, should produce excellent alfalfa and sweetclover. Generally speaking, however, the utilization of the heavy soils is a major problem in the Milk River area.

An irrigation economic conference, composed of the leading farmers and business men of the valley and extension specialists from Montana State College of Agriculture, was held at Malta in November, 1927. The consensus of opinion at this conference was that the foundation of successful farming under irrigation rests on the following principles: (1) Rotation of crops, which includes at least one high producing cash crop and a legume. Sugar beets probably offer the best possibilities as a cash crop on the medium-heavy and lighter-textured soils of the valley, and either sweetclover or alfalfa may be used as the legume crop in the rotation. (2) A cultivated crop should be grown as an aid in weed control. Beets, potatoes, or corn will serve this purpose. (3) Livestock, such as dairy cattle, beef cattle, sheep, or hogs, or a combination of these are considered essential to success on most farms, as they utilize feeds produced on the farm, and their care furnishes profitable winter employment for the farmer.

Economic studies in the Milk River Valley indicate that the average farm should include a minimum of about 80 acres of good crop land in order that a good crop rotation may be established and sufficient feed produced to carry some livestock. In order that 80 acres of good crop land may be included it may be necessary to have a farm ranging in size from 120 to 160 acres.

Alfalfa may be included in the rotation, or it may be replaced by sweetclover. A rotation somewhat similar to the following is recommended: Alfalfa, 3 years; grain (wheat, oats, or barley) or potatoes, 1 year; sugar beets, 2 years; followed by grain reseeded back to alfalfa or sweetclover. The farm should include about 10 acres of permanent pasture which it is estimated should carry the equivalent of 1.5 steers an acre for the season.

The livestock which the individual farmer might be expected to carry would vary somewhat with the kind kept and the production of the various kinds of crops. This can be adjusted to the individual farmer's needs and inclinations.

The economic conference emphasized the fact that irrigation farming presents problems regarding the utilization of the land, maintenance of soil fertility, and weed control, which are more serious problems than occur under dry-land conditions. This, together with the addition of a greater cost through land investment, water charges, and construction charges, requires greater managerial ability in order to succeed than dry-land farming.

SOILS AND THEIR INTERPRETATION

The Milk River area is located in the northwestern part of the Great Plains which slope gently downward from the Rocky Mountains to the Mississippi Valley. The area, extending 170 miles from

east to west, is included within the parallels 48° and 48° 40′ N. and meridians 106° 15′ and 109° 45′ W. The elevation ranges from 2,042 feet above sea level on the eastern border of the area to an average of about 2,500 feet in the alluvial plain on the western border. The points of extreme elevation in the western part are about 2,750 feet.

The factors of soil formation, as determined by geographic environment, do not vary sufficiently over different parts of the area to produce marked differences in the soils. The mature soils of the well-drained upland may therefore be considered as a unit, as they belong in one general soil zone, corresponding to the chestnut-brown zone of Europe.

The Milk River area lies a short distance west of the chernozem belt where the soils have attained the maximum blackness for well-drained soils. In this area the moisture supply is too low to allow the accumulation of a large quantity of organic matter. Precipitation is also too low to leach out the soluble salts to as great a depth as in the chernozem belt. As a result, the soils in this area are dark grayish brown rather than very dark grayish brown or black, their dark surface layers are thinner, and the layer of lime accumulation is nearer the surface.

The temperature does not range widely in the Milk River area. The mean annual temperature at Glasgow in the eastern part is 40.8° F., and at Havre in the extreme western part it is 41.5°, the maximum temperatures for the two points are 113° and 103°, respectively and the minimum —56° and −57°, respectively. Precipitation normally decreases from the eastern part of the area toward the western part, but as the weather bureau stations are few and the records do not cover a sufficient time, the exact rate of decrease westward can not be definitely given. As a result of the high temperature, the dry atmosphere, and, at certain periods, hot dry winds, evaporation is rapid during the summer months. Consequently the available soil moisture is decreased.

The principal differences in the soils of this area are due, therefore, to the rather wide differences in the character of the parent materials. During the Pleistocene epoch, the region was entirely overrun by glaciers, and the surface was covered to various depths by glacial débris. Erosion has removed a part of the glacial drift in nearly all parts of the area and has removed it entirely over the greater part, including all stream slopes and ravines. The underlying rock, exposed in places, consists of alternating beds of shales and sandstones, Bear Paw shale, Judith River sandstone, and Claggett shale being exposed in sufficiently large areas to form soils. Claggett shale, which is somewhat lighter colored than Bear Paw shale, outcrops in the big bend section of the area north and east of Malta. The shales of the two formations contain little lime or other carbonates, but the sandstone contains a large amount.

The survey of this area was chiefly concerned with the alluvial flood plains of Milk River, as this is the land covered by the irrigation project. The area mapped, however, in order to cover all the alluvial lands, includes the slopes and in places small parts of the smoother upland. It includes the deep soils of the flood plains and

higher terraces and the thin soils of the more or less eroded upland borders. Some of the upland and high terrace soils have been exposed to the soil-forming processes a sufficient length of time to acquire the typical regional profile, but this profile is seen in only a small proportion of the flood-plain lands. Where the alluvium consists of either gravel or heavy sediments it has resisted the soil-forming agencies. In places soluble salts strongly influence the character of the soil, even at the surface. Lack of drainage in places has also retarded the development of the regional profile, or produced an abnormal profile.

The soils that have developed and retained the regional profile occur most typically on comparatively small areas on the remnant of smooth upland. The surface layer to a depth of 1 or 2 inches is a loose mulch, the material of which is grayish brown, slightly lighter in color than the layer below. On grassy lands this layer is held together by grass roots forming a turf. The next lower layer, which extends to a depth of 6 or 7 inches below the surface, is dark brown. The material of this layer may be coarsely granular, but in most places it is only cloddy. It is underlain to a depth of 12 or 14 inches by a brown or dark grayish-brown layer which is usually heavier in texture and more compact than the layers above, and the structure in most places is columnar or prismatic. As a rule, the zone of lime accumulation is 12 or more inches thick and lies immediately under the heavy layer. The material of the lime zone is loose, structureless, lighter in texture, more friable than in the layers above, and is light grayish brown, specked and streaked with white lime. Below the lime zone is the parent material which, under the smooth upland soils, is mottled brown and gray structureless drift. The general profile described is representative of the Scobey soils on the glaciated upland and of the better-drained terrace soils of the Beaverton series. The brown heavy columnar layer of the Scobey soils shows the effects of alkali, and the results of all degrees of salinity up to the well-developed solonetz of Phillips loam can be observed.

Phillips loam is developed to small extent in this area and very extensively in the surrounding region. Its occurrence is characterized by a large number of "slick spots" as a result of a solonetz development. The surface soil was originally covered by a gray loose structureless and deflocculated layer containing a large proportion of silt or very fine sand. This layer is underlain by brown heavy tough columnar clay, beneath which is the zone of carbonate accumulation. Gypsum crystals are abundant immediately below the heavy clay layer. The removal of the loose deflocculated layer by the wind leaves the heavy clay or solonetz layer exposed in spots which are bare of vegetation.

A number of soils in the area have not developed the regional profile and their characteristics are dominated largely by the parent material. Such soils are grouped in the Marias and Orman series and include the colluvial phase of Beaverton fine sandy loam. The Marias soils have a grayish-brown silty mulchlike surface layer, below which and continuing to a depth of 10 inches is a dark grayish-brown or olive-brown layer, in most places heavy in texture and

somewhat columnar in structure. The underlying material is calcareous olive-gray massive clay which becomes lighter in color and more friable with increase in depth. Lime, in most places, begins at a depth of less than 18 inches, and at a depth of 30 inches streaks and spots of lime and gypsum are abundant. This soil has developed over parent material derived largely from shale which is resistant to the soil-forming processes.

The Orman soils are developed over colluvial and alluvial material removed by erosion from shale areas and redeposited in the valleys.

The soils of the Milk River flood plain have been grouped into three series, namely, Havre, Harlem, and Bowdoin. These soils owe their distinguishing characteristics mainly to the influence of their parent materials but to some extent to the degree of development under the agency of the soil-forming processes. The surface soils of members of the Havre series range from fine sandy loam to silty clay loam and the subsoils from fine sandy loam to very fine sandy loam. The surface soils of members of the Harlem series are darker than the corresponding layers of the Havre soils as a result largely of shale influence, and for the same reason they are heavy in texture, but the subsoils are lighter in color and texture. The soils of the Bowdoin series are characterized by dark-gray surface soils and extremely heavy dark-gray or dark olive-gray subsoils. The color may become somewhat lighter below a depth of 30 inches.

Table 14 shows the results of pH determinations for four soils of the Milk River area. These results were obtained by E. H. Bailey by the hydrogen-electrode method.

TABLE 14.—*pH determinations of soils in the Milk River area, Montana*

[1½ c. c. soil 1 : 2 soil-water ratio]

Sample No	Soil type	Depth	pH	Sample No	Soil type	Depth	pH
		Inches				*Inches*	
470533	Scobey clay loam	0- 2	7.39	470563	Marias clay loam	32-44	7.73
470534	do	2- 8	7.09	470564 [1]	do	44-54	8.43
470535	do	8-19	8.60	470520	Harlem clay	0-27	7.82
470536 [1]	do	19-35	7.75	470521 [1]	do	27-36	8.51
470537 [1]	do	35-45	7.77	470522 [1]	do	36-50	8.02
470560	Marias clay loam	0- 1	7.59	470523	Bowdoin clay	0-28	8.22
470561	do	1-10	8.37	470524	do	28-36	7.83
470562	do	10-32	6.82	470525 [1]	do	26-52	7.92

[1] Contains lime concretions.

SUMMARY

The Milk River area is in northern Montana, in the northwestern part of the Great Plains of the United States. The area consists largely of rather level valley land, but it includes some level or undulating benches and rough land bordering the valley. Milk River receives the drainage waters of the entire area.

The climate is characterized by comparatively long winters and short vigorous growing seasons. The mean annual rainfall ranges from 10 to 15 inches in various parts of the area.

The main line of the Great Northern Railway provides adequate transportation facilities, though the long distance to markets is a

disadvantage that must be offset by shipping products of good quality only.

The soils of the area may be grouped into two general classes, uplands and bottom lands. The uplands may be divided into glacial and residual soils. These soils are dry farmed. The bottom lands, which have been grouped in three soil series, are being developed by irrigation.

The irrigated lands are used for the growing of grain and hay, mainly alfalfa, and for raising livestock. Special crops, such as sugar beets, certified seed potatoes, and registered alfalfa seed, are receiving increased attention and are ordinarily grown in conjunction with the general farm crops.

A considerable area of vacant and undeveloped land, that might well be supporting an increased population, still remains.

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP

MILK RIVER AREA—EASTERN SHEET
MONTANA

MONTANA AGRICULTURAL EXPERIMENT STATION
F. B. LINFIELD, DIRECTOR
WILLIAM DeYOUNG, IN CHARGE DETAIL SURVEYS

Thomas D. Rice, Inspector, District 3.
Soils surveyed by William DeYoung, Montana Agricultural Experiment Station, in charge, and F. O. Youngs and T. W. Glassey, U. S. Department of Agriculture.

Scale $\frac{1}{62500}$
1 ½ 0 1 2 3 4 Miles

Field Operations
Bureau of Chemistry and Soils
1928

U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP

MILK RIVER AREA—WESTERN SHEET

MONTANA

MONTANA AGRICULTURAL EXPERIMENT STATION
F. B. LINFIELD, DIRECTOR
WILLIAM DE YOUNG, IN CHARGE DETAIL SURVEYS

Thomas D. Rice, Inspector, District 3.
Soils surveyed by William DeYoung, Montana Agricultural Experiment Station, in charge, and F. O. Youngs and T. W. Glassey, U. S. Department of Agriculture.

BASE MAP IN PART FROM
U. S. GEOLOGICAL SURVEY SHEETS

Scale $\frac{1}{62500}$

WILLIAMS & HEINTZ CO. WASH., D.C.

Field Operations
Bureau of Chemistry and Soils
1928